

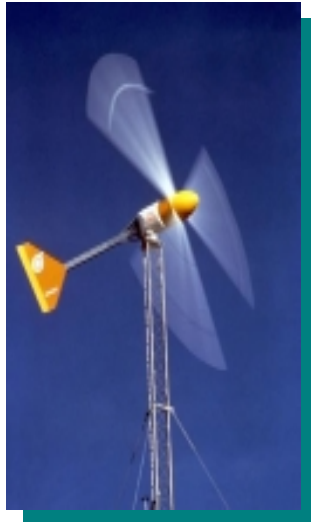
# Wind Technology: New Developments and Markets

*Harvesting Clean Energy Conference  
January 29-30, 2001  
Spokane, Washington*

Brian Parsons  
Project Manager, Wind Applications  
National Renewable Energy Laboratory

email: *brian\_parsons@nrel.gov*  
(303) 384-6958

# Sizes and Applications

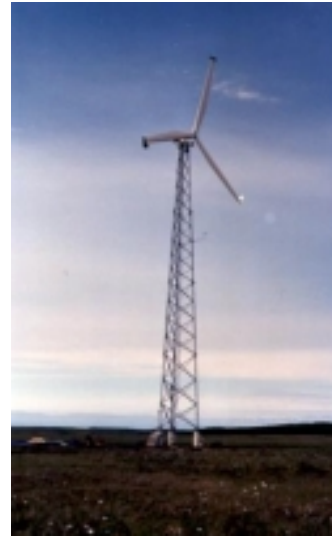


## **Small ( $\leq 10$ kW)**

**Homes**

**Farms**

**Remote Applications  
(e.g. water  
pumping, telecom  
sites, icemaking)**



## **Intermediate (10-250 kW)**

**Village Power**

**Hybrid  
Systems**

**Distributed  
Power**



## **Large (250 kW – 2+ MW)**

**Central Station Wind  
Farms**

**Distributed Power**

# A MATURING WIND TECHNOLOGY



- Technology has matured over 25 years of learning experiences
- Availabilities reported of 98-99%
- Certification to international standards helps to avoid “show stoppers”
- Performance and cost have dramatically improved
  - hardware issues are being promptly addressed
- New hardware is being developed on multiple fronts:
  - higher productivity and lower costs
  - larger sized for both land and off-shore installations
  - tailored designs for high capacity factor, low wind speed and extreme weather conditions

# A STRONG U.S. MARKET IS EVOLVING



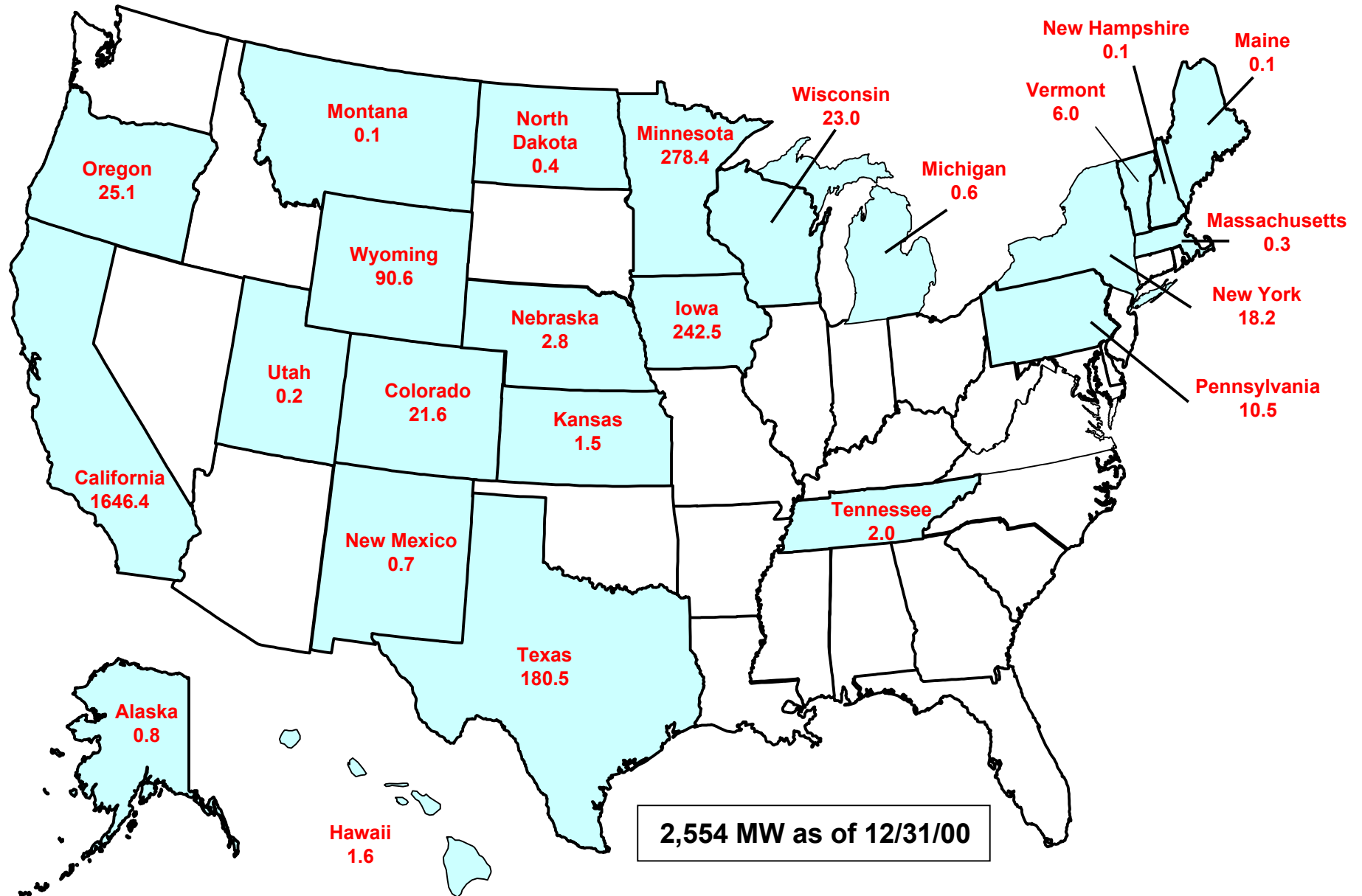
- Currently 2,500 MW installed, expect nearly 4,500 MW by the end of 2001
- Most current successful markets take advantage of Federal and State incentives, as well as customer preference for green energy
- Policies will continue to have a major influence on markets until wind energy costs drop
- The Wind Powering America program is stimulating further market interest, and participation of Federal loads
- Future markets will include both large wind farms and smaller, distributed installations

# THE WIND INDUSTRY

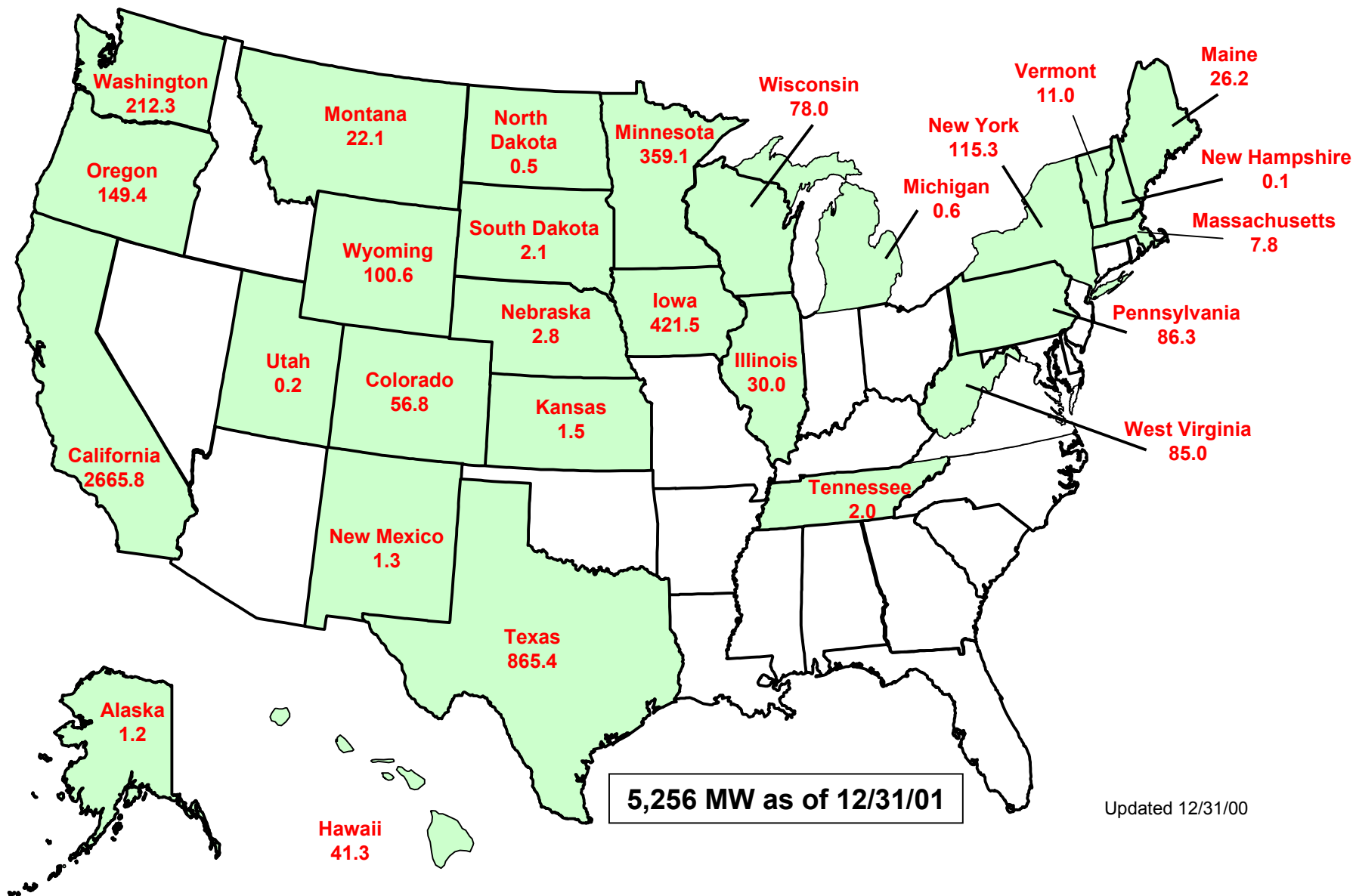


- Major Established International Players
  - Turbine & Component Manufacturers
  - Project Developers, Financial Institutions
  - Project Owners & Operators
- Manufacturing Capability is keeping up with market growth of 30% per year
- Manufacturers are offering warranties on performance
- 25 years of experience has led to over 1 Billion operating hours world-wide
- New Players are entering the market to meet projected demand growth

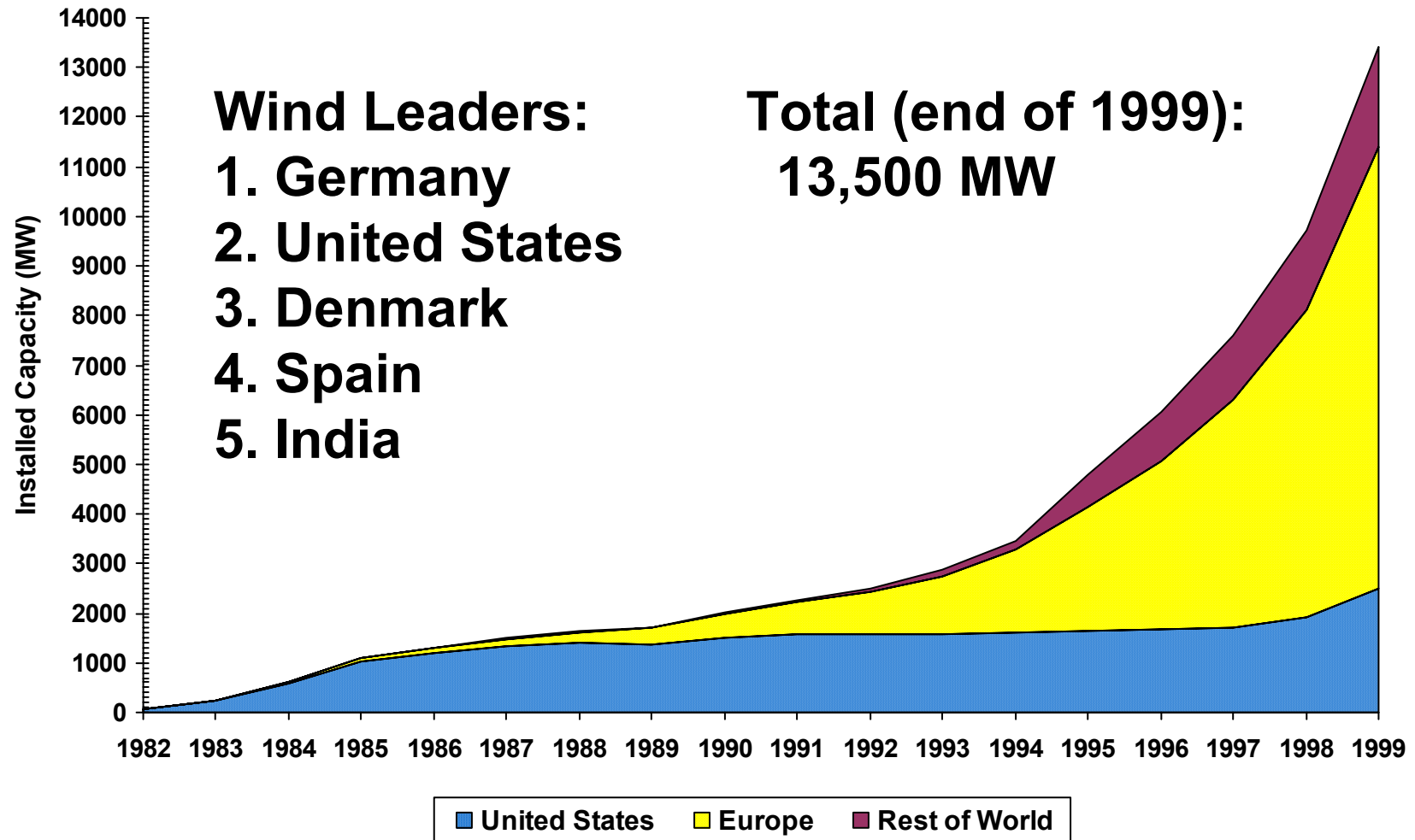
# United States Wind Power Capacity (MW)



# U.S. Wind Power - Expected by end of 2001 (MW)

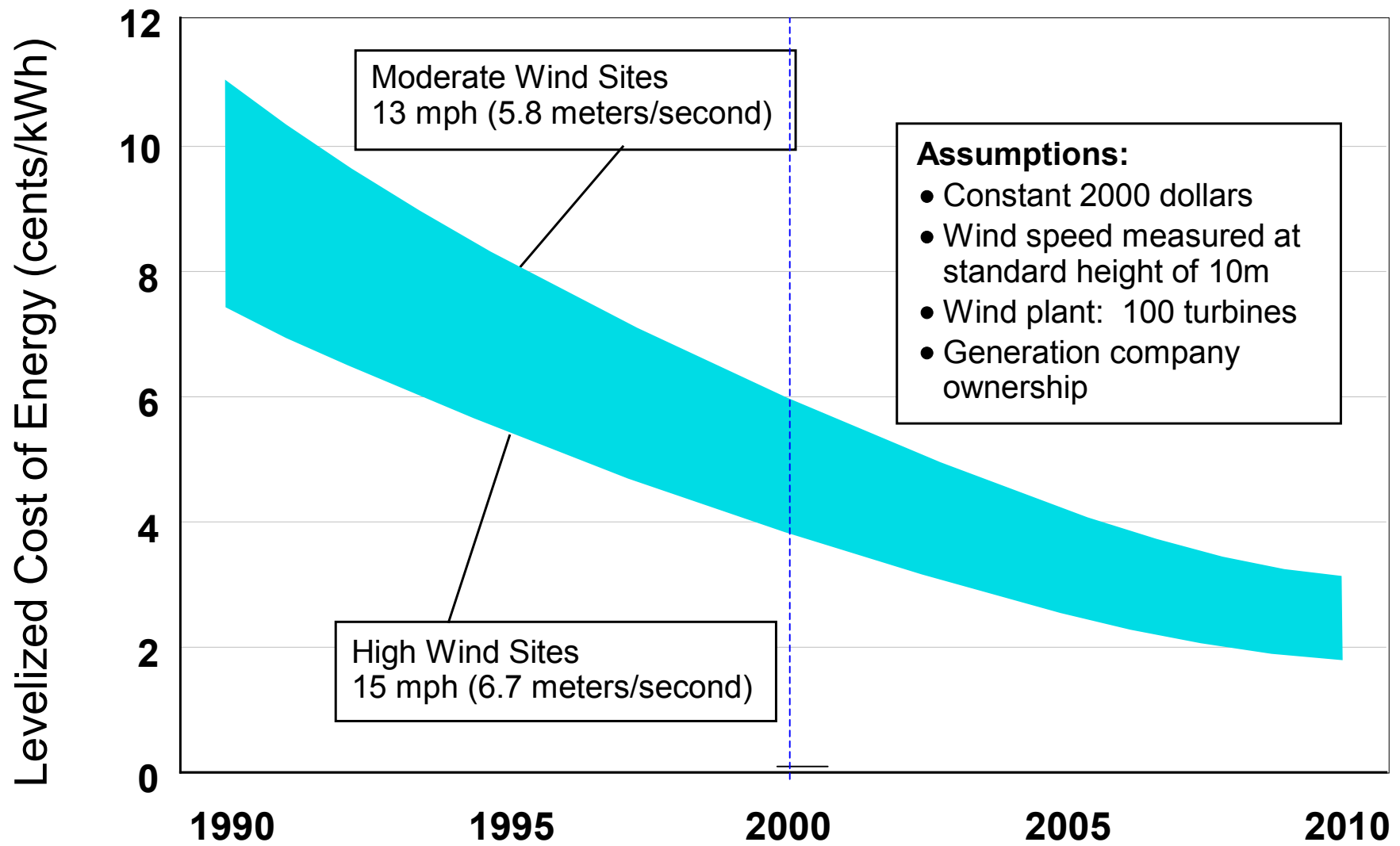


# Taking Off Worldwide



Based on information supplied by International Energy Agency.





# Economic Development Opportunities

- Land Lease Payments: 2-3% of gross revenue  
\$2500-4000/MW/year
- Local property tax revenue: 100 MW brings in on the order of \$1 million/yr
- 1-2 jobs/MW during construction
- 2-5 permanent O&M jobs per 50-100 MW,
- Local construction and service industry: concrete, towers usually done locally
- Investment as Equity Owners: production tax credit, accelerated depreciation
- Manufacturing and Assembly plants expanding in U.S. (Micon in IL, LM Glasfiber in ND)



# Why is Wind different ?

- Intermittent
  - firm/non-firm rates (low capacity factor)
  - scheduling penalties
  - reliability contribution
  - ancillary services
- Remote (& location specific)
  - little excess capacity
  - constrained flow to major load centers
- New
  - not part of established processes
  - expansion and upgrades have been few due to uncertain cost recovery and NIMBY

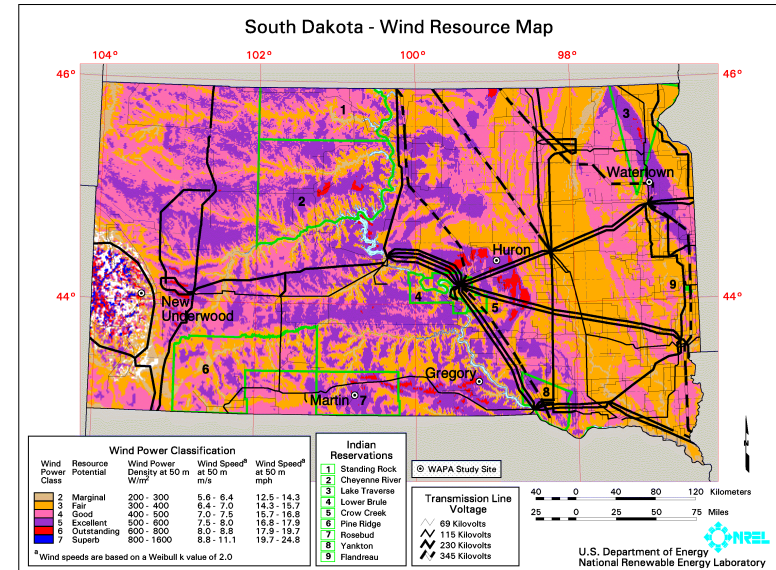


# But... *It really depends*

## Location, Location, Location

- Resource

- 1 mph in average speed is ~ 0.5 cents/kWh
- Raising tower from 50 to 100m increases kWh ~15% or more in class 4-5
- Coincidence of wind with load increases value



- Permitting

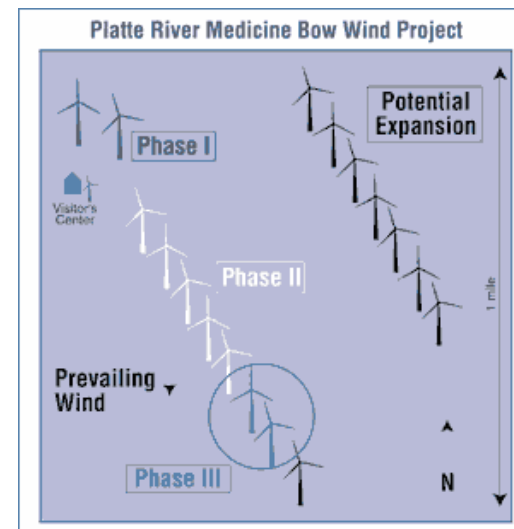
- private vs. public land
- state and local regulations

- Existing site expansion

- quick, low cost option

- What is included

- transmission, land



# Finances and Incentives

- Production Tax Credit
  - 1.7 cents/kWh (escalating) for 10 years equates to around 1.1 cents/kWh reduction in contract price
  - deadline pressure *increases* costs
- State and Local tax, etc. can be significant
  - +/- 0.5 cents/kWh impact
- Public Power (100% debt at tax free rates)
  - 60% of GenCo or IPP cents/kWh
- Renewable Energy Production Incentive
  - annual appropriations problem leads to little impact





# Plant and Turbine Size

- Spread “nearly fixed” costs: permitting, crane, legal and other soft costs
- Volume discount from manufacturer
- Economies of scale may bring O&M to under 0.2 cents/kWh
- Next generation of 1.2-2.0 MW machines are 10-15% cheaper/kW



# Wind Energy Value



- Emissions free power beginning to have additional value
  - green markets
  - emissions credits
- Reliability/capacity value
- Fuel/Resource diversity and risk
- Intermittency
  - non-dispatchable (different types of kWh)
  - ancillary service costs ??

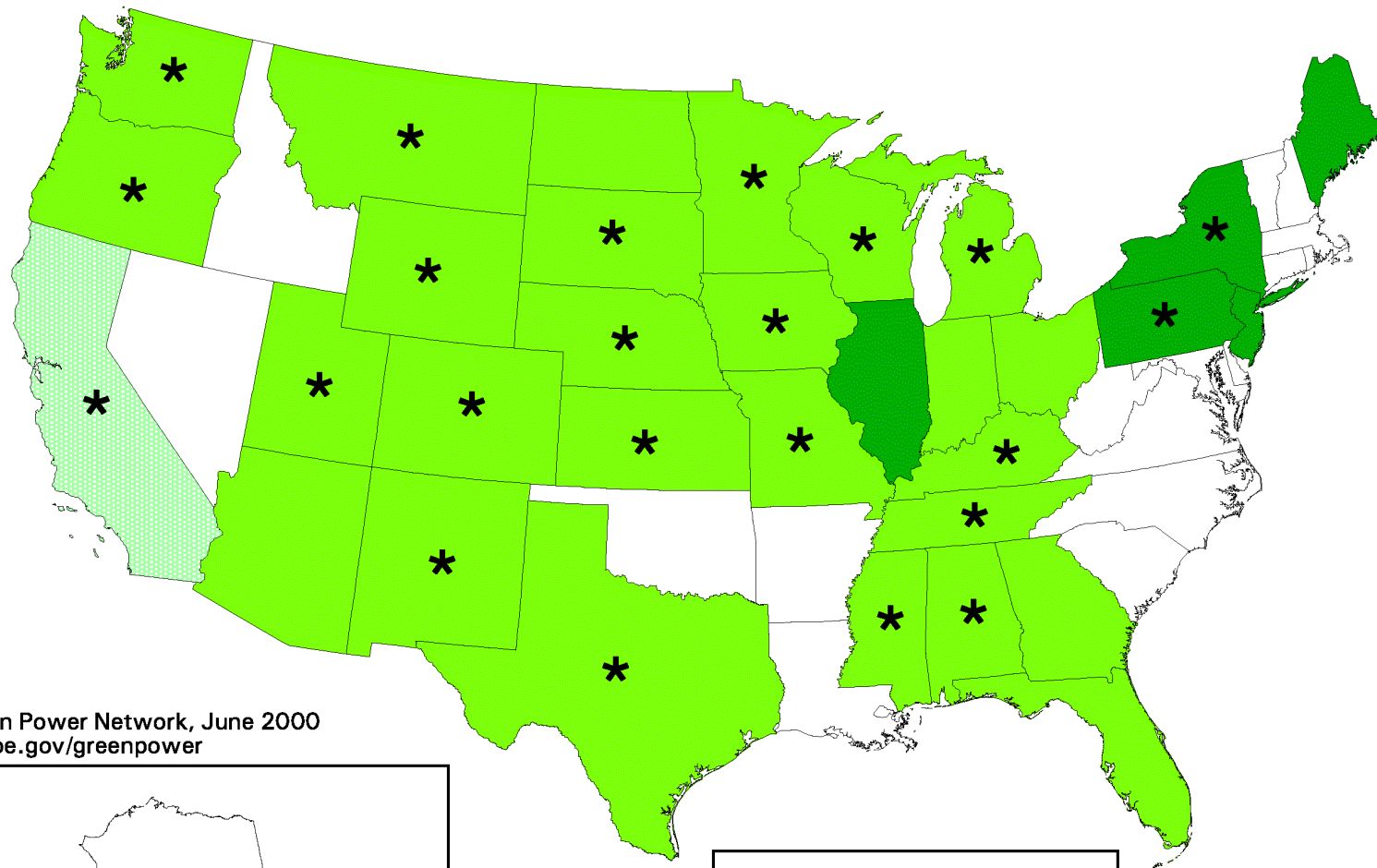
# Cost Conclusions

- The wind industry is delivering ~ 3 cent/kWh contracts, including PTC for large projects
- This price will likely be higher for small projects in new locations
- Value side important: but cost dominates in domestic markets today

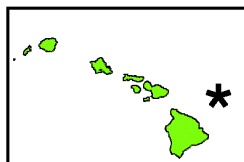
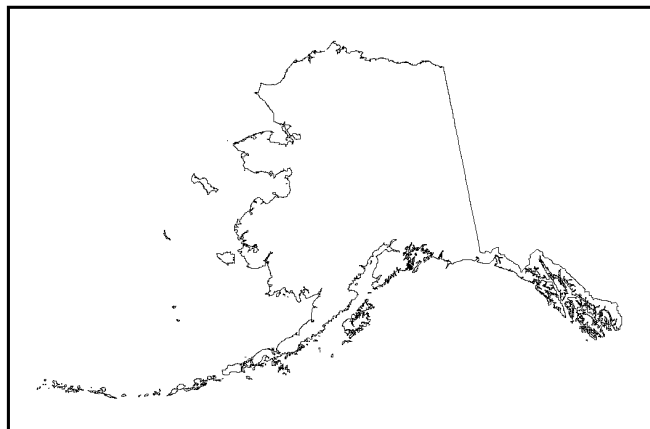




## United States - Green Pricing and Green Power



Source: Green Power Network, June 2000  
[www.eren.doe.gov/greenpower](http://www.eren.doe.gov/greenpower)



### Legend

- Green Pricing - Utility green pricing programs exist or are being developed
- Green Market - Retail and/or wholesale green power products available
- Green Pricing & Green Market
- \* Wind Included

US Dept. of Energy - National Renewable Energy Laboratory



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# Green Tags - Benefits

## To Customer

- Lower cost option
- Opportunity to buy green power if regulated market and no green pricing program offered by utility provider
- Able to aggregate facilities across utility service territories/states/country
- Option for leased facilities that don't pay utility bill
- Requires less staff time

## To Supplier

- Contract with green power retail energy supplier not required for renewable developer
  - Simply sell electrons into grid as generic electricity
  - Transmission contract from renewable site to end-use customer not required
- Increased siting flexibility

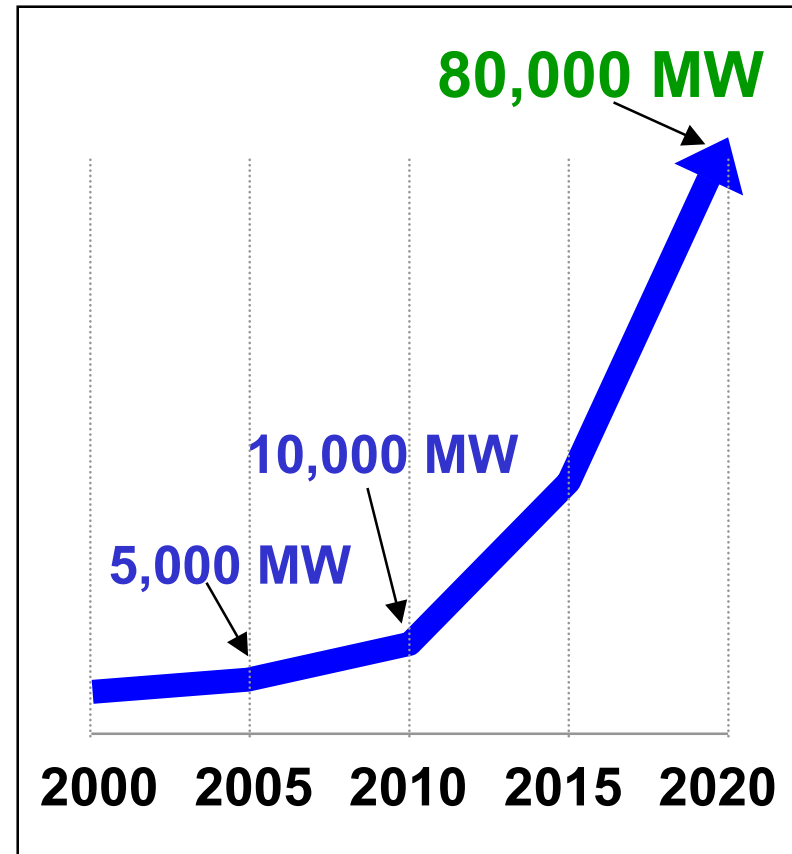
# Federal Goals

## Government Facilities

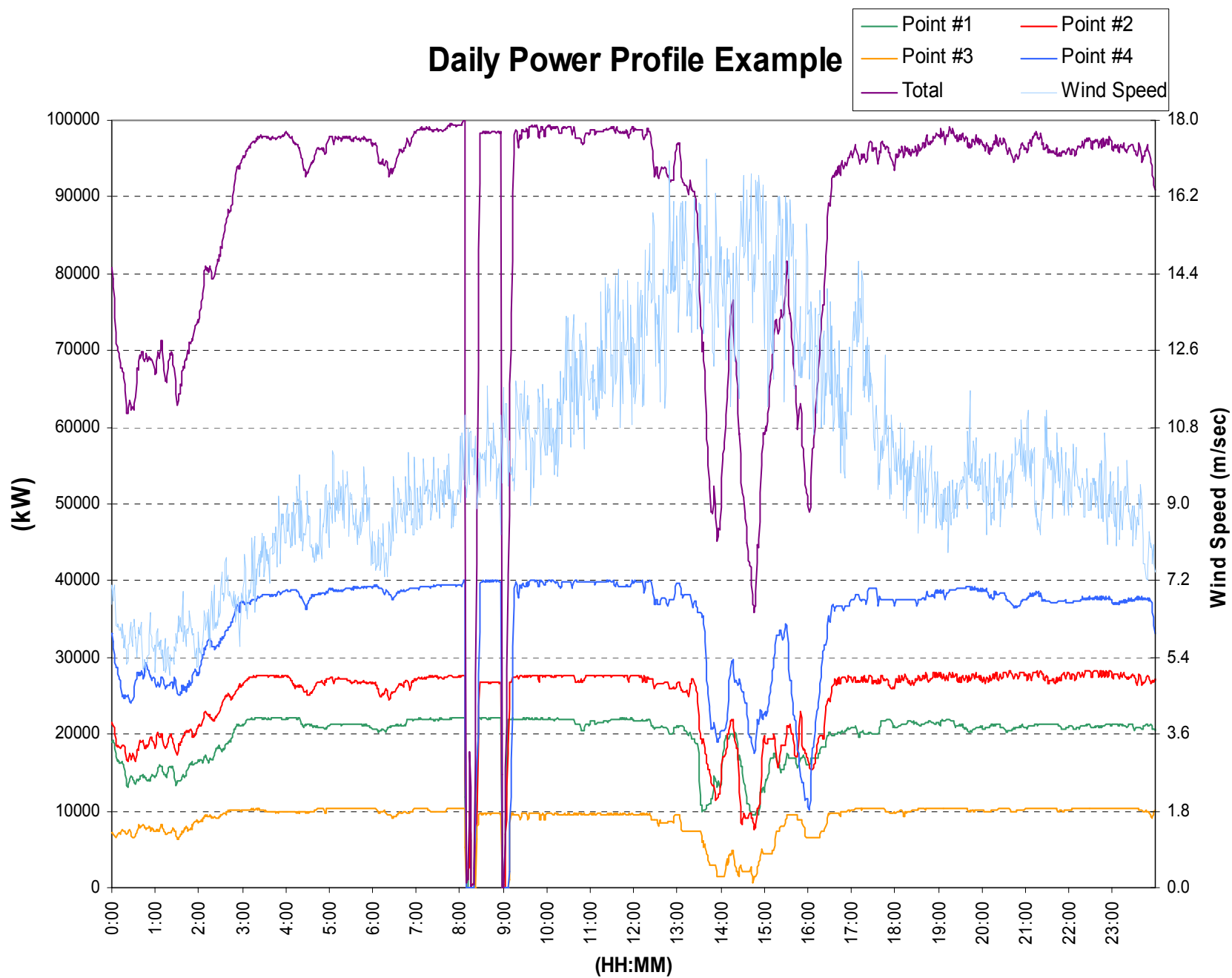
- DOE - 3% RE by 2005; 7 1/2% by 2010
- WPA Federal aggregation- 100 MW by 2001
- FedREWG - 2 1/2% RE by 2005 (pending)

## Wind Powering America

- 5% of the nation's electricity with wind by 2020
- Double the number of states with > 20 MW of wind capacity to 16 by 2005, and triple to 24 by 2010



## Daily Power Profile Example



# Land Owners, Communities, Economic Development and Local Government Officials

- Messages
  - Wind as a new “crop” for local income and economic development
- Actions
  - formulate facilitating wind-rights and ownership structures (like wind coops)
  - develop zoning and permitting procedures that recognize wind development characteristics and needs
  - develop streamlined project-approval processes



# Regulators, Government Officials and other Policy Makers

- Messages
  - acceptable economic returns and policies that recognize site/time specific value (not just avoided cost) are needed
  - Interconnection requirements based on reasonable safety and operational considerations need to be standardized
- Actions
  - promote standards development, minimize individual or special studies
  - support publicly funded infrastructure
  - support new valuation methods



# Financial Community

- Messages
  - Financing institutions in Europe provide financing with procedures and terms like standard farm equipment.



- Actions
  - Evaluate risk levels appropriate for distributed project financing.
  - Develop standard financing processes and products to minimize transaction costs.
  - Work to develop power-purchase mechanisms and project ownership structures that reduce risk of project investment.

# Wind Farm Issues

- Policy
- Siting
- Standards
- Transmission
- Hardware
- Intermittency



# Wind Farm Issues

- Policy
  - Parity with other energy sources
  - Encourage economic development and use of local resources
  - energy diversity
  - no fuel price risk
  - hidden subsidies for conventional power
  - facilitate “green” markets
- Mechanisms
  - Restructuring: Portfolio standards, System benefits funds
  - Standard purchase tariffs
  - Taxes: sales, income, property
  - Bidding Evaluations: full competitive, account for more than short-term costs

# Siting

- Avian and other wildlife
- Noise
- Visual
- Land Ownership

# Standards

- Hardware certification
- Interconnection
  - transmission
  - distribution

# Transmission

- Grid Access
- System studies
- Allocation of available capacity
- Scheduling and costs for usage
  - firm
  - non-firm

# Hardware

- Lightening
- Extreme Winds
- Corrosion
- Extreme temperatures

# Intermittency

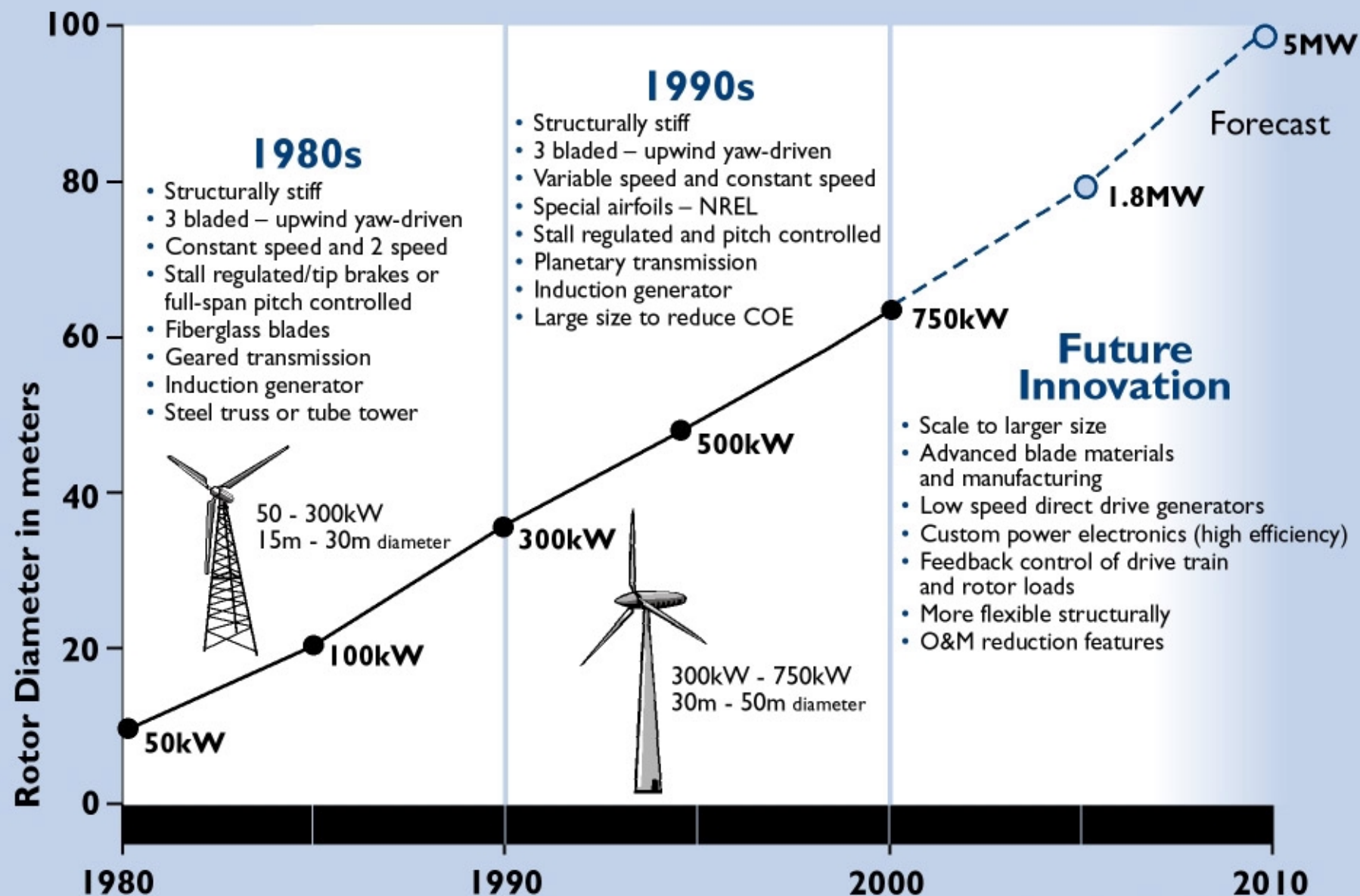
- Capacity Factor (energy)
- Capacity Credit/Reliability
  - time match with load
  - probabilistic (like forced outage with conventional power)
- Operational Impacts (ancillary services)
  - voltage/VAR control, load following, etc.

*10-20% of system capacity is reasonable without impacts*



NREL

# THE EVOLUTION OF COMMERCIAL U.S. WIND TECHNOLOGY



Source: Thresher & Dodge, Wind Energy Journal 1998